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## Using Behavioral Risk Factor Surveillance System data to estimate the percent of the population meeting USDA Food Patterns fruit and vegetable intake recommendations

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### Abstract

Most Americans do not eat enough fruits and vegetables with significant variation by state. State-level self-reported frequency of fruit and vegetable consumption is available from the Centers for Disease Control and Prevention's Behavioral Risk Factor Surveillance System (BRFSS). However, BRFSS cannot be used to directly compare states' progress towards national goals because of incongruence in units used to measure intake and because distributions from frequency data are not reflective of usual intake. To help states track progress, we developed scoring algorithms from external data and applied them to 2011 BRFSS data to estimate the percent of each state's adult population meeting United States Department of Agriculture Food Patterns fruit and vegetable intake recommendations. We used 24 hour dietary recall data from the 2007–2010 National Health and Nutrition Examination Survey to fit sex- and age-specific models that estimate probabilities of meeting recommendations as functions of reported consumption frequency, race/ethnicity, and poverty-income ratio adjusting for intra-individual variation. Regression parameters derived from these models were applied to BRFSS to estimate percent meeting recommendations. We estimate that 7–18% of state populations met fruit recommendations and 5–12% met vegetable recommendations. Our method provides a new tool for states to track progress towards meeting dietary recommendations.

### Keywords

fruits; vegetables; recommended intake; states

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Despite the numerous benefits of consuming adequate amounts of fruits and vegetables, most Americans do not eat nearly enough.(1) Higher intakes of both contribute important nutrients frequently lacking from Americans' diets (2) and reduce the risk of heart disease, (3) stroke,(4) diabetes,(5) and some cancers.(6) Substituting fruits and vegetables for higher calorie foods may also aid in healthy weight management.(2, 7, 8) Fruit and vegetable intake recommendations vary by sex, age, and physical activity level according to the United States Department of Agriculture (USDA) Food Patterns, one of the dietary patterns consistent with the Dietary Guidelines for Americans 2010.(2) American adults should be consuming 1.5–2 cup equivalents of fruits and 2–3 cup equivalents of vegetables daily depending on their age and sex.(9, 10) Physically active adults should consume more. One cup is approximately equal to one medium apple, eight strawberries, 12 baby carrots, or one large tomato.(9, 10)

Twenty-four hour dietary recall data from the National Health and Nutrition Examination Survey (NHANES) are the source for monitoring national progress towards meeting USDA Food Patterns fruit and vegetable recommendations, hereafter referred to as federal recommendations. Because significant state variation in consumption exists,(11) there is also a need to monitor state-specific progress. However, NHANES does not have an adequate sample size to produce state-specific estimates. The sole surveillance system that tracks state-level adult fruit and vegetable intake is the Centers for Disease Control and Prevention's Behavioral Risk Factor Surveillance System (BRFSS).

Biennially since 1994, BRFSS has asked respondents to report frequency of fruit and vegetable intake via a brief food frequency screener module. The module asks how many times per day, week, or month various fruit and vegetable groups are consumed. While the BRFSS fruit and vegetable module can track national and state specific changes in reported frequencies of consumption, the module cannot be used to directly compare the progress states are making towards meeting national goals or federal recommendations. Previously, BRFSS data were used to estimate the percent of adults consuming fruits and vegetables 5 or more times daily and percent consuming fruit 2 or more times and vegetables 3 or more times daily(12) in line with the 5-A-Day for Better Health Program and Healthy People 2010 objectives (consume 2 fruit servings and 3 vegetable servings daily).(13, 14) However, times per day and servings per day are not equivalent, (15) the 5-A-Day Program was discontinued in 2007, and Healthy People 2020 Objectives are now measured in cup equivalents per 1000 calories.(16) Federal fruit and vegetable intake recommendations are also measured in cup equivalents that are not directly comparable to frequency data from BRFSS.

To address this gap in monitoring state-level progress towards meeting national goals, we developed a method to estimate the percent of the population meeting federal fruit and vegetable intake recommendations for the 50 states and the District of Columbia using times per day data from the 2011 BRFSS.

## METHODS

To estimate the percent of each state's population meeting recommendations, we extended a scoring procedure (17) that used 2003–2006 NHANES 24 hour dietary recall (24HR) data and ordinary least squares regression to estimate cup equivalents consumed from consumption frequency and median portion sizes for selected food groups. The prediction model is then applied to screener frequency data to predict mean cup equivalents consumed. We built upon the original scoring procedure in four ways. First, we used data from a more recent source, NHANES 2007–2010.(17) All NHANES 2007–2010 participants 18 years of age and older with reliable 24HRs were included (N=11,742 participants; 1,561 participants with 1 day of recall and 10,181 participants with 2 days of recall). Second, we accounted for intra-individual variation. Because individuals do not eat the same foods and amounts of food each day, intra-individual variation may lead to an overestimation of the percentage of persons with very low or very high usual intakes.(18) The original procedure only estimated mean intake, which is not affected by this variation. Third, we revised the fruit and vegetable food groups to parallel the food groups currently asked about in the 2011 BRFSS (100% fruit juice, fruit, dried beans, dark green vegetables, orange vegetables, and other vegetables). Last, we accounted for variation in portion sizes by using eight sex- and age-specific models to be consistent with prior research assessing compliance with federal dietary recommendations. (1) An overview of the method for estimating percent meeting fruit intake recommendations is presented in Figure 1.

### **NHANES times per day each fruit and vegetable group was consumed (independent variable)**

The first variable calculated from NHANES 24HRs was the reported number of times per day fruits and vegetables were consumed. To calculate this, all foods and beverages were sorted based on main ingredients into one of the 6 fruit and vegetable food groups in the 2011 BRFSS module or labelled as all other foods (see Web Appendix 1).(19) We then summed the number of times each participant reported any food classified into one of the six fruit and vegetable groups for each day of report. The following foods were excluded to make calculated times per day from NHANES better reflect the types of foods that are typically reported when adults are asked food frequency screener questions like those in BRFSS: beverages other than 100% fruit juice, fried potatoes, baby foods, dried fruit, condiments including tomato sauces (salsa, ketchup, spaghetti sauce, etc.), olives, pickles, relishes, vinegars, and fruits and vegetables eaten in combination with sandwiches (i.e. lettuce and tomatoes on sandwiches). Fried potatoes and non-100% fruit juices were excluded because BRFSS explicitly instructs respondents not to include these items. Baby foods were excluded because these analyses are intended for use in adult populations. The other foods were excluded because cognitive testing indicates that when adults are asked food frequency screener questions similar to the BRFSS questions, they do not report these types of foods without explicit prompting.(20–22) We compared extracted frequencies for 100% fruit juice, fruit, and legumes using only 2009–2010 24HRs to reported frequencies from 3 similar items from the 26-item diet screener in 2009–10 NHANES to test the validity of these assumptions. Frequencies extracted from NHANES were used as the independent variable in the scoring procedure models.

### NHANES cup equivalents from all sources of fruits and vegetables (dependent variable)

The second variable calculated from the NHANES dietary recall data was reported cup equivalents of fruits and of vegetables consumed from all food sources in the 24HRs except fried potatoes and non-100% fruit juice beverages. This variable includes foods and beverages previously excluded when estimating times per day variable (baby foods, dried fruit, condiments, olives, pickles, relishes, vinegars, and fruits and vegetables eaten in combination with sandwiches). USDA Food Patterns Equivalents Databases 2007–2008 and 2009–2010 were used to disaggregate all reported foods and beverages except fried potatoes and non-100% fruit juices into their ingredients and estimate cup equivalents of fruits and vegetables consumed by each respondent.(23–26) For each individual, cup equivalents of fruits and vegetables from all relevant food sources were totaled for each day of report. Total cup equivalents of fruits and total cup equivalents of vegetables were used as the dependent variables in the scoring procedure models.

### Estimating percent meeting recommendations

The two variables above were used to simulate samples of individual usual intake amounts fit via one or two part nonlinear mixed models using macros provided by the National Cancer Institute (NCI).(27) These simulated intakes reflect relationships between usual intake amounts, reported frequencies of the 6 fruit and vegetable groups per day, and demographic covariates, after adjusting for intra-individual variation and systematic differences between weekend (Friday–Sunday) versus weekday (Monday–Thursday) intake and between the first and second 24HR. Each simulated usual intake amount was classified as meeting or not meeting the recommendation. The resulting binary variables were modeled using logistic regression with the reported frequencies of the 6 fruit and vegetable groups per day used in the usual intake model to obtain prediction equations for the log odds of meeting federal fruit and vegetable intake recommendations (9, 10). Equations were also developed that estimate usual amounts of fruits and vegetables consumed.

For these analyses, recommended amounts of fruits and vegetables for sedentary individuals were used (Table 1). All modeling accounted for the NHANES survey design. Consistent with prior work, sex- and age-specific one or two part models were estimated for males and females separately for fruits and vegetables (18–30, 31–50, 51–70, and 71 years of age).(1, 28) A two-part nonlinear mixed model was used to estimate the usual fruit intake distributions for all sex-age groups since fruit was consumed episodically (4% – 44% of 24HR days had zero intake). (1, 29) Part I models, represented below, model the probability of consuming fruit (cup equivalents of fruit consumed > 0) by extracted times per day fruit juice and whole fruits were consumed for each NHANES participant's day of recall. Part II fruit models for model the amount of fruit consumed in cup equivalents by the frequencies of fruit juice and fruit intake for each reported recall day. Part I and Part II models were fit simultaneously. Additional details regarding how models were fit are available from prior work. (29) One-part models were used to estimate the usual vegetable intake distributions for all sex-age groups because they were consumed almost daily by everyone (i.e. days of zero intake ranged from 5–8%).(1, 29) Models for vegetables modeled the amount of vegetables consumed in cup equivalents by the extracted times per day dried beans, dark green vegetables, orange vegetables, and other vegetables were consumed.

Dummy variables were included in models to account for variation due to collecting 24HR on weekends versus weekdays and first versus second 24HR, and also for demographic covariates, poverty-income ratio (PIR)(30) and race/ethnicity. To be consistent with prior work estimating the percent meeting recommendations and to fully account for each person's intake given all their own covariates, not just population averages, we account for race/ethnicity and PIR to explain some of the variation observable between usual intake and times per day fruits and vegetables are eaten. PIR was categorized as two dummy variables: <1.25 and 1.25–3.49 versus the referent group of >3.49. Race/ethnicity was categorized with two dummy variables: Hispanic and non-Hispanic Black versus a referent group of all others.

#### Two part model for fruit

##### Part I: Probability of consumption model with a person-specific random effect

$$\log(\text{probability of consuming fruit}) / (1 - \text{probability of consuming fruit}) = \beta_0 + \beta_1(T_{\text{fruit juice}}) + \beta_2(T_{\text{fruit}}) + \beta_3(\text{Weekend effect}) + \beta_4(\text{Day of recall}) + \beta_5(\text{Hispanic}) + \beta_6(\text{non-Hispanic Black}) + \beta_7(\text{PIR} < 1.25) + \beta_8(\text{PIR } 1.25 - 3.49) + \text{person specific effect}$$

where  $T_{\text{fruit juice}}$  and  $T_{\text{fruit}}$  = Number of times 100% fruit juice and fruit consumed on each 24-hour recall and the person-specific effect is normally distributed

##### Part II: Consumption amount model with a person-specific random effect

$$\text{Transformed cup equivalents of fruits consumed from all sources} = \beta_0 + \beta_1(T_{\text{fruit juice}}) + \beta_2(T_{\text{fruit}}) + \beta_3(\text{Weekend effect}) + \beta_4(\text{Day of recall}) + \beta_5(\text{Hispanic}) + \beta_6(\text{non-Hispanic Black}) + \beta_7(\text{PIR} < 1.25) + \beta_8(\text{PIR } 1.25 - 3.49) + \text{person specific effect} + \text{within-person variability}$$

where the person-specific effect and within-person random variability are normally distributed

The logistic regression prediction equations from the NHANES models (see Web Table 1) were then applied to BRFSS to obtain individual BRFSS participants' log odds of meeting recommendations. The times per day each BRFSS participant reported eating each fruit and vegetable group and each participant's PIR and race/ethnicity were substituted for the frequency and demographic covariates in the prediction equations, respectively. Data from 2011 BRFSS participants aged 18 years or older with complete data were analyzed (n=393,169 of 506,467). Participants were excluded if they did not reside in the 50 states and the District of Columbia (n=8,500), their reported fruit or vegetable frequency exceeded upper limits of acceptable dietary data values (reported eating fruit > 16 times per day or vegetables > 23 times per day; n=105)(15) or they were missing responses to 1 or more questions (n=48,422). Reported frequencies of fruit and vegetable intake were converted into daily frequencies (weekly frequencies were divided by 7; monthly by 30; and yearly by 365). Categories for PIR and race/ethnicity were identical to those described for NHANES. To calculate PIR in BRFSS, the midpoint of reported household income was used for those

who reported their household income (n=393,169). Household size was assumed to be one for the 55,875 participants who did not report the number of individuals residing in the household.

Logistic regression prediction equation for fruit:

$$\log(\text{probability of meeting recommendation}) / (1 - \text{probability of meeting recommendation})_{\text{sex-age group } i} = \beta_0 + \beta_1(T_{\text{fruit juice}}) + \beta_2(T_{\text{fruit}}) + \beta_3(\text{Hispanic}) + \beta_4(\text{non-Hispanic Black}) + \beta_5(\text{PIR} < 1.25) + \beta_6(\text{PIR } 1.25 - 3.49)$$

where  $p(\text{meeting recommendation})$  = probability of meeting the fruit intake recommendation for sex age group  $i$  and  $T_{\text{fruit juice}}$  and  $T_{\text{fruit}}$  = Number of times 100% fruit juice and fruit consumed on each 24-hour recall

To obtain the total and state-specific estimates of percent of the population meeting recommendations, first individual BRFSS participant's predicted probabilities of meeting recommendations were calculated from their log odds of meeting recommendations from the prediction equations.

$$p(\text{meeting recommendation}) = e^{\log\left(\frac{p(\text{meeting recommendation})}{1-p(\text{meeting recommendation})}\right)} / \left(1 + e^{\log\left(\frac{p(\text{meeting recommendation})}{1-p(\text{meeting recommendation})}\right)}\right)$$

Amounts of fruits and vegetables consumed by each BRFSS participant were also estimated (see Web Table 2). Predicted amounts participants consumed were divided by their recommended intake and averaged to obtain the percentages of the recommended amounts of fruits and vegetables consumed. Weighted averages of the predicted probabilities and percentages of the recommendations met were computed using SAS 9.3.2 (SAS Institute Inc., Cary, NC) and SAS Callable SUDAAN 10.1 (RTI International, Research Triangle Park, NC) to account for BRFSS's complex, multistage, probability survey design. The methodology permits estimation of distributions not only for individual sex-age groups but also for collapsed groups such as all adult females and for other demographic characteristics like race/ethnicity and PIR for comparison purposes. See Web Appendix 2 for SAS Callable SUDAAN code. Variation in the prediction equations was accounted for using the Balanced Repeated Replication technique and replicate weights designed for use with NHANES. Variation due to the BRFSS sampling design was accounted for using Taylor linearization. Confidence intervals were calculated using standard errors that reflect variation from the combination of both survey sources.

## RESULTS

Extracted times per day and cup equivalents from all sources averaged over the number of reported days from the NHANES 24HRs are shown in Table 2 by selected demographics. Overall, 19% of the sample (unweighted) reported zero fruit intake compared to 2% for vegetables. Vegetable intake was twice the reported intake for fruits (1.11 times per day for vegetables and 0.53 times per day for fruit). Median cup equivalents of fruits and vegetables



consumed from all sources was 0.69 cup equivalents for fruits and 1.28 cup equivalents for vegetables. Zero fruit intake was more common among males, younger age groups, non-Hispanic blacks, and those with a PIR <1.25. Older age groups and those with a PIR of > 3.49 reported the highest intake of fruits and vegetables and non-Hispanic blacks had the lowest intake as measured by reported times per day and cup equivalents. Extracted frequencies were similar to reported frequencies in the NHANES diet screener (data not shown). Median times per day from BRFSS were typically higher than those reported in NHANES.

Regression parameters for the prediction equations are shown in Web Table 1 and 2, respectively. National and state specific median fruit and vegetable intake in cup equivalents, percentages of the recommended amount consumed, and percentages of the population meeting or exceeding fruit and vegetable intake recommendations generated from applying these equations to BRFSS data are shown in Table 3. Median times per day of fruits and vegetables reported consumed in BRFSS are shown as well. Total median daily intake of fruit reported from BRFSS was 1.1 times per day, ranging from 0.9 to 1.3 times per day. Total median intake of vegetables was higher than fruit intake at 1.6 times per day ranging from 1.4 to 1.9 times per day. Based on estimates from the prediction equations, on average BRFSS participants consumed approximately 60% of the recommended amount of fruit per day and 63% of the recommended amount of vegetables per day. Approximately 14% percent of the total population met fruit recommendations (95% confidence interval 12.9%, 15.0%) and 8.2% met vegetable recommendations (95% confidence interval 4.7%, 12.0%). Percent of state populations meeting recommendations ranged from 7.0% in West Virginia to 18.1% in the District of Columbia for fruits and from 4.7% in Louisiana to 11.5% in Oregon for vegetables. Among those who consumed fruits and vegetables, on average, 63% of the variation in the amounts of fruits and vegetables they consumed is explained by their reported frequency of fruit and vegetable intake rather than demographic information (range by sex age group: 54–73%).

## DISCUSSION

The analytical method we used is a novel application of an existing method that provides a way to estimate the distribution of dietary data from a short frequency screener. It uses the NCI method to estimate distributional tail probabilities from screeners and provides a tool for states to gauge progress towards federal recommendations using the BRFSS dietary screener.(9, 10) We found that only 14% of BRFSS participants met or exceeded fruit intake recommendations and 8% met or exceeded vegetable recommendations. The prevalence of meeting recommendations varied by state; however, in no state did more than 19% of the population meet fruit recommendations or more than 12% meet vegetable recommendations.

BRFSS is the only source of dietary surveillance data for most states. While some states including California, Arkansas, and Wisconsin, have independent surveillance systems that measure adult intake of fruits and vegetables, published metrics derived from those systems are not directly comparable to those developed here.(30, 31) However, it is possible to compare our estimates to national estimates. Using 2007–2010 NHANES 24HRs, NCI reported that 14% of American adult males and 24% of adult females met or exceeded fruit

recommendations and 13% and 16% of males and females met or exceeded vegetable recommendations (32). We estimated that 14% of adults met or exceeded fruit recommendations (10.5% for males and 17.5% females, data not shown) and 8% met or exceeded vegetable recommendations (6.8% for males and 9.8% for females, data not shown). At least two methodological differences might explain the differences in estimates.

First, our estimates of percent meeting recommendations do not include non-100% fruit juice contributions or fried potatoes while NCI estimates include both of these sources. We excluded these sources because BRFSS specifically instructs respondents not to include these items. Including these food sources increases the estimated percent meeting recommendations using BRFSS data for fruit from 10.5% and 17.5% to 11.1% and 18.2% for males and females, respectively, and from 6.8% and 9.8% to 9.8% to 12.7% for vegetables (data not shown). Second, BRFSS and NHANES are designed and administered differently which may contribute to differences in estimates of both times per day variables and percentages meeting recommendations. BRFSS is administered via a telephone survey, refers to intake over the past month, and only provides usual frequencies consumed of 6 fruit and vegetable food groups. NHANES frequencies are derived from what people reported eating or drinking over the past 24 hours on at least one day collected via an in-person interview during a comprehensive health examination. A second recall is administered via the telephone 3–10 days later but accompanied by materials obtained during the in-person examination.

There are at least 2 strengths to this analysis. First, this is the first proposed method to estimate distributions and thus percentages reaching some threshold from frequency screeners. The original method we adapted to accomplish this was developed to convert an individual respondent's screener responses to estimates of mean intake and may underestimate median cup equivalents consumed by about 0.5 cup equivalents.(33) We extended this method by using previously validated NCI usual intake methods (34) to estimate the distribution of usual intake. While applied to BRFSS data to allow tracking of state level progress towards a federal recommendation, the methodology could also be used with other screeners. Second, when calculating the total cup equivalents of fruits and vegetables from NHANES (the dependent variable), we included foods often not considered by participants when they respond to brief screeners like BRFSS, such as mixtures and condiments. By including intake of these foods as background intake via the intercept, our prediction equation may give us a better estimate of fruit and vegetable intake. However, there are several limitations that should be noted. First, the two sources of data used in generating the percent meeting fruit and vegetable recommendations had different recall timeframes (24 hours versus 30 days). We applied statistical methods to estimate usual intake from the 24HRs when generating the prediction equations but information elicited from a screener like BRFSS is inherently different from those generated from 24HRs. Second, we could not assess how internally valid the methodology is overall or by subgroup by comparing predicted intake to intake from 24HRs using the BRFSS population. Our estimates including fried potatoes and non-100% fruit juice were 3–6 percentage points lower than the NCI estimates. In the absence of a true gold standard to measure predictions against, comparability of our estimates to national estimates from 24HRs establishes the consistency of our methodology with other more established methods for estimating percent



meeting recommendations. In the absence of an unbiased biomarker for fruits and vegetables, estimates from carefully done multiple 24-hour recalls are considered the next best reference instrument. We compared 3 items from the NHANES 2009–2010 screener to our extracted times per day from the 24 hour recalls to compare how well our extracted times per day imitated actual screener responses as well as comparing our overall estimates to national estimates. Further research is needed in an external population to compare estimates of the percent meeting the population generated from 24HR recalls to estimates generated from items similar to the BRFSS screener to test the validity of the method. Work is underway currently to calibrate the NHANES screener directly to the multiple 24 hour recalls administered to the same respondents and to test the robustness of the resulting calibration scoring algorithms. Future application of this analytic approach to the 3 items common to both screeners will enhance our understanding of the method's validity. Third, our method assumes that the prediction equations are time-invariant. Examining change over time in predicted estimates alongside changes in median intake may help establish how reasonable this assumption is. Fourth, even though the data are weighted to account for nonresponse and to reflect the national population, both NHANES and BRFSS may be subject to selection bias. Median BRFSS survey response rate was 50% for all states and Washington, DC, in 2011 ranging from 34% to 64%.<sup>(35)</sup> In 2007–2010, NHANES had an interviewed response rate of 78–79% and an examined response rate of 75–77%.<sup>(36)</sup> Fifth, almost 10% of BRFSS participants had missing fruit and vegetable data ( $n=48,422$ ). These individuals were significantly ( $p<.0001$ ) more likely to be older (60 versus 55 years) and have a poverty-income ratio  $<1.3$  (29% versus 19%) than those who were not missing frequency data and be non-Hispanic black or Hispanic (20% versus 14%)(data not shown). Including individuals who had complete data for fruit intake but were missing information on vegetable intake did not significantly affect percent meeting fruit recommendation estimates. Including individuals who had complete information on vegetable but not fruit intake similarly did not affect vegetable estimates. Last, of the 449,440 BRFSS participants who had complete information for fruit and vegetable intake and resided in the study area, 13% ( $n=56,271$ ) were excluded because they did not report household income. Household size was assumed to be one for the 55,875 participants who did not report the number of individuals residing in the household but otherwise had complete information. Estimated percentages meeting recommendations were similar when PIR and median household size was imputed for these individuals based on age, sex, and race/ethnicity.

Identification of public health nutrition problems and effective management of nutrition intervention programs require an ongoing collection of relevant nutritional status and program data.<sup>(37)</sup> While there is regular national fruit and vegetable intake monitoring via NHANES, national data have limited value in tracking state and local health objectives and the effects of state and local nutrition programs because the data are not representative of states and localities.<sup>(38)</sup> State and local level data are important for catalyzing local interest in nutrition programs and designing and evaluating programs.<sup>(38)</sup> Our analysis enhances current surveillance efforts by enabling the comparison of intake of fruits and vegetables generated through the widely used BRFSS dietary screener to federal recommendations. Notably, because BRFSS yields state and some local data and the fruit and vegetable questions are asked every two years, our method provides a unique tool for tracking changes

in the percent of state residents meeting fruit and vegetable intake recommendations over time.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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## Abbreviations

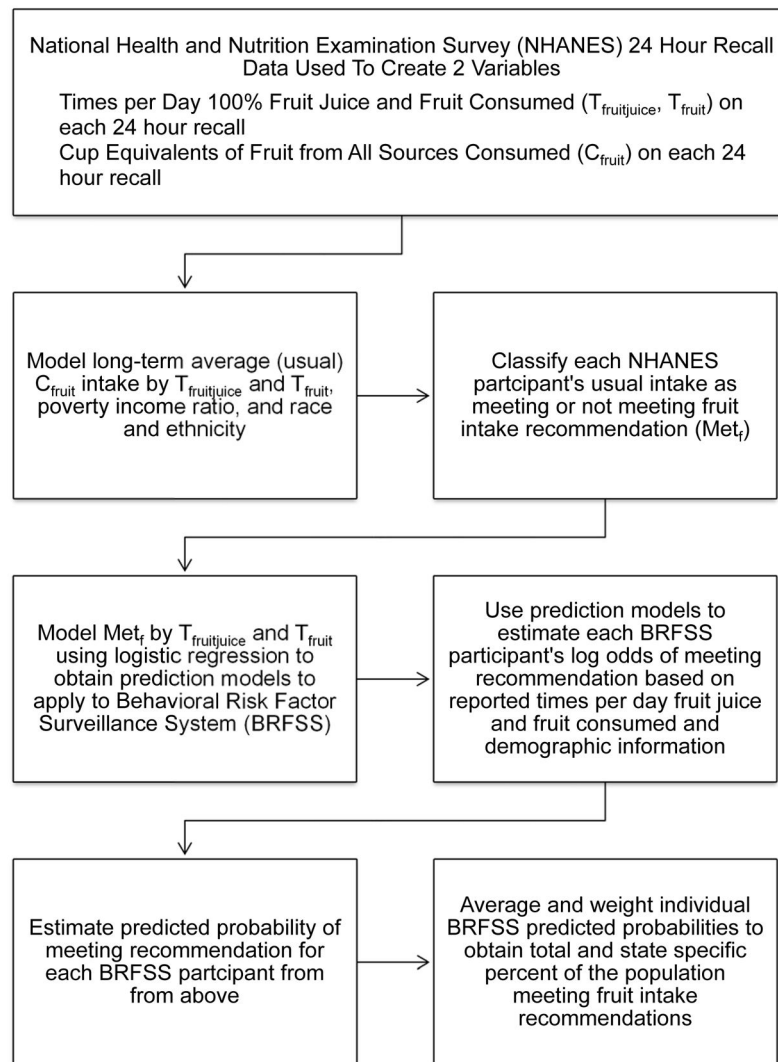
<b>24HR</b>	24 hour dietary recall
<b>BRFSS</b>	Behavioral Risk Factor Surveillance System
<b>NCI</b>	National Cancer Institute
<b>NHANES</b>	National Health and Nutrition Examination Survey
<b>USDA</b>	United States Department of Agriculture

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**Figure 1.**

Overview of method to estimate percent of the population meeting fruit intake recommendations National Health and Nutrition Examination Survey, United States, 2007–2010, and Behavioral Risk Factor Surveillance System, United States, 2011

**Table 1**Fruits and vegetables: How much is needed daily<sup>a</sup>

Age Range, years, by Sex	Recommended Servings (cups equivalents/day)	
	Vegetables	Fruit
Women		
19–30	2½ cups	2 cups
31–50	2½ cups	1 ½ cups
51+	2 cups	1 ½ cups
Men		
19–30	3 cups	2 cups
31–50	3 cups	2 cups
51+	2½ cups	2 cups

<sup>a</sup>These amounts are appropriate for individuals who get less than 30 minutes per day of moderate physical activity, beyond normal daily activities. (9,10) Those who are more physically active may be able to consume more while staying within calorie needs. (9,10)



Table 2

Fruit and Vegetable Intake by Selected Demographics, National Health and Nutrition Examination Survey, United States, 2007–2010, and the Behavioral Risk Factor Surveillance System, 2011<sup>a</sup>

Characteristic	National Health and Nutrition Examination Survey						Behavioral Risk Factor Surveillance System		
	% with zero intake (unweighted) <sup>c</sup>						Median cup equivalents <sup>e</sup>		
	No. <sup>b</sup>	Fruit	Veg	Fruit	Veg	Median times per day <sup>d</sup>	Fruit	Veg	Median times per day
Total	11,742	19.0	2.0	0.53	1.11	0.69	1.10	1.28	1.63
Females									
18–30	1,289	23.7	2.1	0.31	0.70	0.49	1.10	0.99	1.57
31–50	1,994	18.5	1.9	0.46	1.15	0.52	1.14	1.16	1.78
51–70	1,740	12.4	1.6	0.88	1.72	0.95	1.16	1.42	1.86
71+	964	7.0	1.6	1.18	1.76	0.99	1.43	1.25	1.76
Males									
18–30	1,245	30.0	2.7	0.24	0.49	0.49	1.00	1.19	1.43
31–50	1,825	27.3	2.0	0.27	0.85	0.50	1.00	1.42	1.53
51–70	1,773	17.3	2.0	0.64	1.36	0.81	1.00	1.53	1.56
71+	912	10.9	2.1	1.01	1.54	0.99	1.17	1.39	1.57
Race/ethnicity									
Hispanic	3,381	16.7	1.3	0.58	1.06	0.78	1.14	1.33	1.63
Non-Hispanic Black	2,298	23.4	2.7	0.36	0.68	0.62	1.06	0.90	1.30
Other	6,063	18.6	2.1	0.55	1.20	0.69	1.07	1.32	1.67
Poverty-income Ratio									
< 1.25	4,389	23.2	2.7	0.39	0.87	0.63	1.00	1.13	1.43
1.25–3.49	4,232	18.8	1.8	0.51	1.04	0.66	1.06	1.22	1.57
> 3.49	3,121	13.4	1.2	0.66	1.36	0.79	1.14	1.44	1.77

<sup>a</sup>Estimates are weighted to account for complex sampling using SUDAAN except where noted. Fruit consists of 100% fruit juice and whole fruit. Vegetables include legumes, dark green and orange vegetables, and other vegetables.

<sup>b</sup>No. = Unweighted number of participants

<sup>c</sup>Percent of people with zero intake over 1 or 2 24-hour recall days. 1,561 have 1 recall day and 10,181 have 2 recall days. Estimates are unweighted.

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Only foods that parallel BRFSS questions were counted in times per day. Estimates were averaged over number of recall days.

Total cup equivalents per day of fruits and vegetables from all sources except fried potatoes and beverages other than 100% fruit juice. Estimates were averaged over number of recall days.

Fruit And Vegetable Intake, Behavioral Risk Factor Surveillance System, United States, 2011<sup>a,b</sup>

Table 3

State	No. <sup>c</sup>	Median Times per day		Percent of the recommended amount consumed <sup>d</sup>		Percent meeting or exceeding the recommendations <sup>d,e</sup>	
		Fruit	Veg.	Fruit	Veg.	Fruit	Veg.
All states	393,169	1.1	1.6	59.4	63.1	13.8	8.2
Alabama	5,773	1.0	1.6	52.1	60.5	10.4	6.5
Alaska	2,744	1.1	1.7	59.2	66.5	13.8	9.8
Arizona	5,139	1.1	1.7	60.5	66.2	14.5	10.3
Arkansas	3,666	1.0	1.5	53.0	59.7	11.7	6.8
California	15,189	1.3	1.9	67.4	68.2	17.7	11.4
Colorado	10,691	1.1	1.7	61.2	66.0	14.5	9.6
Connecticut	5,448	1.3	1.7	65.4	65.1	17.0	9.1
Delaware	3,810	1.0	1.6	55.1	60.6	11.5	6.3
District of Columbia	3,682	1.3	1.9	66.8	65.8	18.1	11.2
Florida	9,512	1.1	1.6	61.4	63.0	15.0	8.4
Georgia	7,748	1.0	1.6	55.7	61.3	12.3	7.2
Hawaii	6,520	1.0	1.7	57.1	65.9	12.9	10.4
Idaho	4,934	1.1	1.6	57.9	64.0	13.0	8.4
Illinois	4,985	1.1	1.6	60.6	61.5	14.0	7.5
Indiana	6,577	1.0	1.5	56.7	61.1	12.7	7.3
Iowa	5,823	1.0	1.4	56.0	59.9	11.9	6.4
Kansas	16,717	1.0	1.6	52.4	63.0	10.2	7.6
Kentucky	6,886	1.0	1.5	49.1	59.6	9.1	6.0
Louisiana	8,160	1.0	1.4	48.4	55.4	8.7	4.7
Maine	11,079	1.2	1.7	62.2	64.9	14.9	8.8
Maryland	7,825	1.1	1.6	60.3	62.0	14.3	7.3
Massachusetts	16,820	1.2	1.7	63.1	64.4	15.4	8.5
Michigan	9,041	1.1	1.6	60.1	62.3	13.9	7.9
Minnesota	12,413	1.1	1.6	58.5	61.3	12.7	6.6
Mississippi	6,913	0.9	1.4	48.5	56.1	9.4	5.5

State	No. <sup>c</sup>	Median Times per day		Percent of the recommended amount consumed <sup>d</sup>		Percent meeting or exceeding the recommendations <sup>d,e</sup>	
		Fruit	Veg.	Fruit	Veg.	Fruit	Veg.
Missouri	4,960	1.0	1.5	52.6	60.8	10.5	7.1
Montana	8,549	1.0	1.6	55.9	63.3	11.9	7.9
Nebraska	21,043	1.0	1.5	56.2	60.9	12.2	7.2
Nevada	4,272	1.1	1.6	61.6	64.2	15.1	9.3
New Hampshire	5,130	1.3	1.8	65.6	67.8	16.7	10.4
New Jersey	11,454	1.1	1.6	60.9	62.9	14.0	7.5
New Mexico	7,503	1.1	1.7	61.6	65.1	15.3	9.3
New York	6,002	1.2	1.6	63.6	63.0	16.1	8.2
North Carolina	8,644	1.0	1.7	54.2	63.3	10.8	7.8
North Dakota	4,213	1.1	1.4	56.8	59.7	12.4	6.2
Ohio	7,659	1.0	1.5	55.7	60.4	11.8	6.8
Oklahoma	7,021	0.9	1.5	48.0	59.6	8.8	5.8
Oregon	4,926	1.1	1.9	63.3	69.4	15.5	11.5
Pennsylvania	8,918	1.1	1.6	60.0	61.7	13.9	7.4
Rhode Island	5,144	1.2	1.7	63.3	64.5	15.5	8.8
South Carolina	9,938	1.0	1.5	53.9	59.0	11.5	6.3
South Dakota	6,606	1.0	1.4	53.1	58.8	10.5	5.5
Tennessee	3,949	1.0	1.6	47.5	59.3	8.4	6.0
Texas	11,830	1.0	1.7	58.8	64.2	13.6	8.8
Utah	10,183	1.1	1.7	61.1	64.3	14.2	8.2
Vermont	5,822	1.3	1.8	64.8	67.5	16.5	10.6
Virginia	5,147	1.1	1.7	58.4	62.4	13.2	7.5
Washington	12,106	1.1	1.7	59.5	65.7	13.4	9.2
West Virginia	4,161	1.0	1.5	46.1	58.5	7.0	5.3
Wisconsin	4,280	1.1	1.5	61.1	60.0	14.5	6.4
Wyoming	5,614	1.1	1.6	58.2	63.7	13.5	8.1

<sup>a</sup> Estimates are weighted to account for complex sampling using SUDAAN except where noted. Fruit consists of 100% fruit juice and whole fruit. Vegetables include legumes, dark green vegetables, orange vegetables, and other vegetables.

<sup>b</sup> Recommendations are age- and sex-specific and appropriate for individuals who get less than 30 minutes per day of moderate physical activity, beyond normal daily activities.

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<sup>c</sup>No.= Unweighted number of participants.

<sup>d</sup>Derived from age- and sex-specific models that account for the usual intake of foods and race/ethnicity, poverty-income ratio, and variation due to collecting 24 hour recall data on weekends versus weekdays and 1<sup>st</sup> versus 2<sup>nd</sup> recalls.

<sup>e</sup>Standard errors for percentages of the population meeting recommendations were 1% for fruit and 3–4% for vegetables.